

WHAT IS CLAIMED IS:

1 1. A high speed mass storage system which is readily expandable to
2 increase its storage capacity while the system is in operation comprising at least one
3 module containing

4 (a) at least one CPU;

5 (b) a plurality of plug-in storage devices for
6 storing information;

7 (c) a storage device bypass circuit board
8 associated with each storage device, each storage device being
9 plugged into a connector on the storage device bypass circuit
10 board;

11 (d) a module bypass circuit board including an
12 optical input/ output connector for outputting electrical signals
13 from the module as light signals and for inputting light signals
14 into the module as electrical signals; and,

15 (e) a controller providing a communication path
16 between the CPU with each of the storage devices through its
17 associated storage device bypass circuit board and through the
18 module bypass circuit board.

1 2. The high speed mass storage system of claim 1 wherein each storage
2 device bypass circuit board includes a circuit which completes the connection of the
3 CPU with the other storage device bypass circuits and their associated storage
4 devices whether or not the storage device is present.

1 3. The high speed mass storage system of claim 1 wherein the module
2 bypass circuit board outputs electrical signals from the at least one module via the
3 optical input/output connector when light signals are received by said optical
4 input/output connector.

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1 4. The high speed mass storage system of claim 1 including first and
2 second modules each including elements (a) through (e), wherein the optical
3 input/output connectors of the modules are connected by a fiber optic transmission
4 medium such that signals are communicated between the modules in the form of
5 light.

1 5. The high speed mass storage system of claim 4 wherein the module
2 bypass circuit board of the first module outputs electrical signals from the first
3 module to the second module via the optical input/output connector when light
4 signals are received from the second module by said optical input/output connector.

1 6. The high speed mass storage system of claim 1 wherein the at least
2 one module includes a storage device bypass board connector for each of the storage
3 device bypass circuit boards with an opening between each connector to permit the
4 flow of air between the connectors and alongside the bypass circuit boards and
5 storage devices for cooling purposes.

1 7. The high speed mass storage system of claim 1 wherein the storage
2 devices are disk drives and the storage device bypass circuit boards are disk drive
3 bypass circuit boards each having a connector to receive a disk drive.

1 8. The high speed mass storage system of claim 7 wherein the at least
2 one module includes a disk drive bypass circuit board connector for each of the drive
3 bypass circuit boards with an opening between each connector to permit the flow of
4 air between the connectors, and wherein each drive bypass circuit board is a
5 relatively flat circuit board with a connector on opposite edges, wherein one of the
6 connectors is the connector which receives the disk drive and the other connector
7 connects to said drive bypass circuit board connector, said connectors, bypass circuit
8 boards and drives being arranged such that when they are connected there is a path
9 for air flow from outside the module alongside each bypass circuit board and its
10 associated disk drive for cooling purposes without any backplane obstruction.

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1 9. The high speed mass storage system of claim 8 wherein the module is
2 housed in an enclosure and at least one fan is mounted to force air from outside said
3 enclosure through the spaces between said bypass boards and drives.

1 10. The high speed mass storage system of claim 1 wherein the controller
2 operates with a Fiber Channel protocol.

1 11. The high speed mass storage system of claim 1 wherein the controller
2 is an arbitrated dual channel Fiber Channel controller.

1 12. The high speed mass storage system of claim 10 wherein each storage
2 device is a disk drive and wherein each storage device bypass circuit board
3 comprises a disk drive bypass circuit board including a circuit which completes the
4 connection of the CPU with the other drive bypass circuits and their associated disk
5 drives whether or not the disk drive is present.

1 13. The high speed mass storage system of claim 12 wherein the module
2 bypass circuit board outputs electrical signals from the at least one module via the
3 optical input/output connector when light signals are received by said optical
4 input/output connector.

1 14. The high speed mass storage system of claim 11 including first and
2 second modules each including elements (a) through (e), wherein the optical
3 input/output connectors of the modules are connected by a fiber optic transmission
4 medium such that signals are communicated between the modules in the form of
5 light.

1 15. The high speed mass storage system of claim 14 wherein the module
2 bypass circuit board of the first module outputs electrical signals from the first
3 module to the second module via the optical input/output connector when light
4 signals are received from the second module by said optical input/output connector.

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1 16. The high speed mass storage system of claim 11 wherein the storage
2 devices are disk drives and the storage device bypass circuit boards are disk drive
3 bypass circuit boards, and wherein the at least one module includes a disk drive
4 bypass board connector for each of the disk drive bypass circuit boards with an
5 opening between each connector to permit the flow of air between the connectors
6 and alongside the bypass circuit boards and disk drives for cooling purposes.

1 17. The high speed mass storage system of claim 12 wherein the at least
2 one module includes a disk drive bypass circuit board connector for each of the disk
3 drive bypass circuit boards with an opening between each connector to permit the
4 flow of air between the connectors, and wherein each disk drive bypass circuit board
5 is a relatively flat circuit board with a connector on opposite edges, wherein one of
6 the connectors is the connector which receives the disk drive and the other connector
7 connects to said disk drive bypass circuit board connector, said connectors, bypass
8 circuit boards and drives being arranged such that when they are connected there is a
9 path for air flow from outside the module alongside each bypass circuit board and its
10 associated disk drive for cooling purposes without any backplane obstruction.

1 18. The high speed mass storage system of claim 17 wherein the module
2 is housed in an enclosure and at least one fan is mounted to force air from outside
3 said enclosure through the spaces between said bypass boards and drives.

1 19. A high speed mass storage system adapted to be readily expandable
2 to increase its capacity while the system is in operation comprising at least one
3 module containing

- 4 (a) at least one CPU;
- 5 (b) a plurality of plug-in disk drives for storing
6 information;
- 7 (c) a disk drive bypass circuit board associated
8 with each disk drive and including a disk drive connector at
9 one edge thereof and a bypass board connector at another edge

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thereof, each disk drive being plugged into said disk drive connector on the disk drive bypass circuit board;

(d) a module bypass circuit board including an optical input/ output connector for outputting electrical signals from the module as light signals and for inputting light signals into the module as electrical signals; and,

(e) a controller connecting the CPU with each of the disk drives through its associated drive bypass circuit board and through the module bypass circuit board such that a loop is formed between the output and input of the controller with each disk drive bypass circuit board and the module bypass circuit board in said loop and completing said loop whether or not a disk drive is plugged into the disk drive connector.

20. The high speed mass storage system of claim 19 including a second module connected to said at least one module via the optical input/output connector, said module bypass circuit board of the at least one module completing said loop through the second module.

21. The high speed mass storage system of claim 19 wherein the module bypass circuit board outputs electrical signals from the at least one module via the optical input/output connector when light signals are received by said optical input/output connector.

22. The high speed mass storage system of claim 20 wherein each of said modules includes elements (a) through (e), wherein the optical input/output connectors of the modules are connected by a fiber optic transmission medium such that signals are communicated between the modules in the form of light.

23. The high speed mass storage system of claim 22 wherein the module bypass circuit board of the at least one module outputs electrical signals from the at

3 least one module to the second module via the optical input/output connector when
4 light signals are received from the second module by said optical input/output
5 connector .

1 24. The high speed mass storage system of claim 19 wherein the at least
2 one module includes a drive bypass board connector for each of the drive bypass
3 circuit boards with an opening between each connector to permit the flow of air
4 between the connectors and alongside the bypass circuit boards and disk drives for
5 cooling purposes.

1 25. The high speed mass storage system of claim 19 wherein the at least
2 one module includes a drive bypass circuit board connector for each of the drive
3 bypass circuit boards, and wherein each drive bypass circuit board is a relatively flat
4 circuit board with a connector on opposite edges, wherein one of the connectors is
5 the connector which receives the disk drive and the other connector connects to said
6 drive bypass circuit board connector, said connectors, bypass circuit boards and
7 drives being arranged such that when they are connected there is a path for air flow
8 from outside the module alongside each bypass circuit board and its associated disk
9 drive for cooling purposes without any backplane obstruction.

1 26. The high speed mass storage system of claim 25 wherein the at least
2 one module is housed in an enclosure and at least one fan is mounted to force air
3 from outside said enclosure through the spaces between said bypass boards and
4 drives.

1 27. The high speed mass storage system of claim 26 wherein each drive
2 bypass circuit board connector is mounted in the same plane in spaced relationship
3 with each other.

1 28. The high speed mass storage system of claim 19 wherein the
2 controller operates with a Fiber Channel protocol.

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29. The high speed mass storage system of claim 19 wherein the controller is an arbitrated dual channel Fiber Channel system.

1 30. The high speed mass storage system of claim 29 wherein each drive
2 bypass circuit board includes a circuit which completes the connection of the CPU
3 with the other drive bypass circuits and their associated disk drives whether or not
4 the disk drive is present.

31. The high speed mass storage system of claim 29 wherein the module
bypass circuit board outputs electrical signals from the at least one module via the
optical input/output connector when light signals are received by said optical
input/output connector.

1 32. The high speed mass storage system of claim 29 including first and
2 second modules each including elements (a) through (e), wherein the optical
3 input/output connectors of the modules are connected by a fiber optic transmission
4 medium such that signals are communicated between the modules in the form of
5 light.

1 33. The high speed mass storage system of claim 32 wherein the module
2 bypass circuit board of the first module outputs electrical signals from the first
3 module to the second module via the optical input/output connector when light
4 signals are received from the second module by said optical input/output connector.

1 34. The high speed mass storage system of claim 29 wherein the at least
2 one module includes a drive bypass board connector for each of the drive bypass
3 circuit boards with an opening between each connector to permit the flow of air
4 between the connectors and alongside the bypass circuit boards and disk drives for
5 cooling purposes.

1 35. The high speed mass storage system of claim 29 wherein the at least
2 one module includes a drive bypass circuit board connector for each of the drive

1 36. The high speed mass storage system of claim 35 wherein the module
2 is housed in an enclosure and at least one fan is mounted to force air from outside
3 said enclosure through the spaces between said bypass boards and drives.